FORUM INDUSTRIA DIGITALE

MECCATRONICA E SOFTWARE PER L'INDUSTRIA

HEIDENHAIN

Enpowered Encoder for Smarter Condition Monitoring

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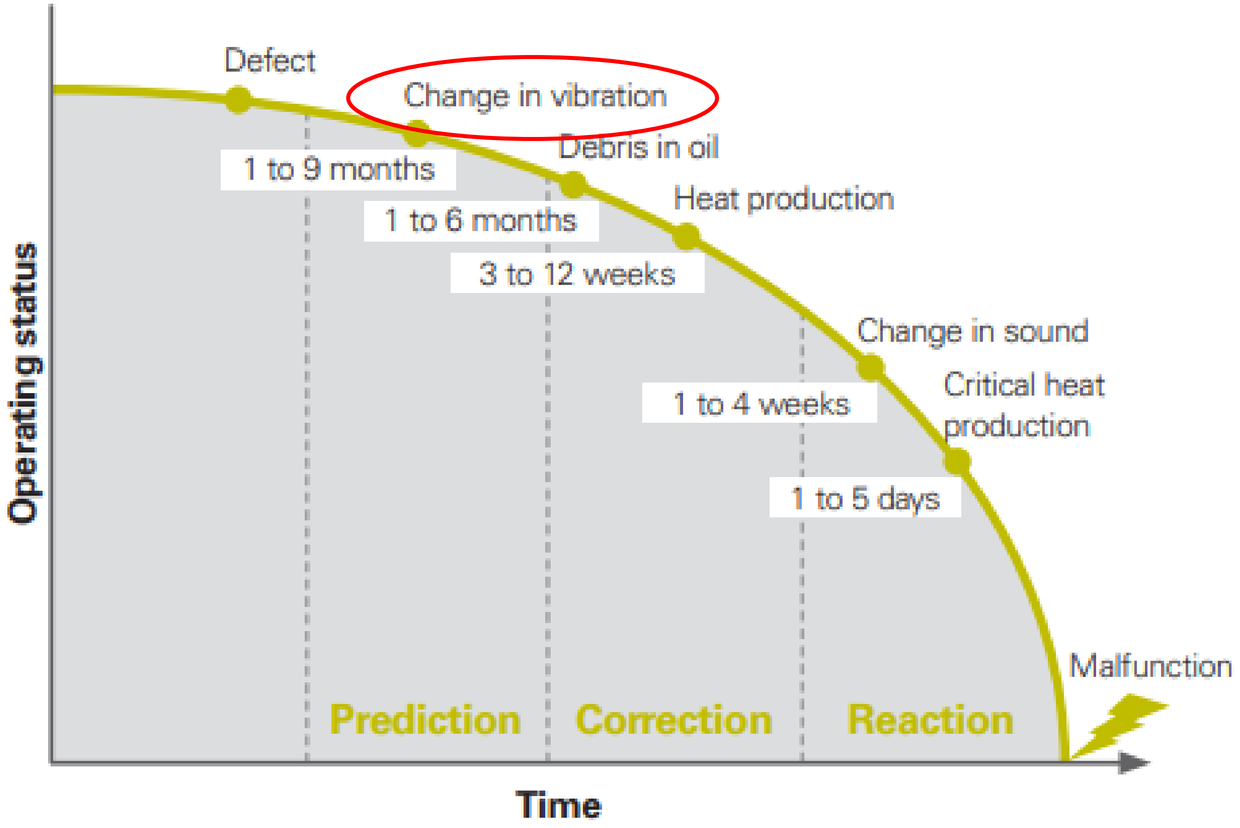
In collaborazione con ORDINE DEGLI INGEGNERI DELLA PROVINCIA DI BRESCIA

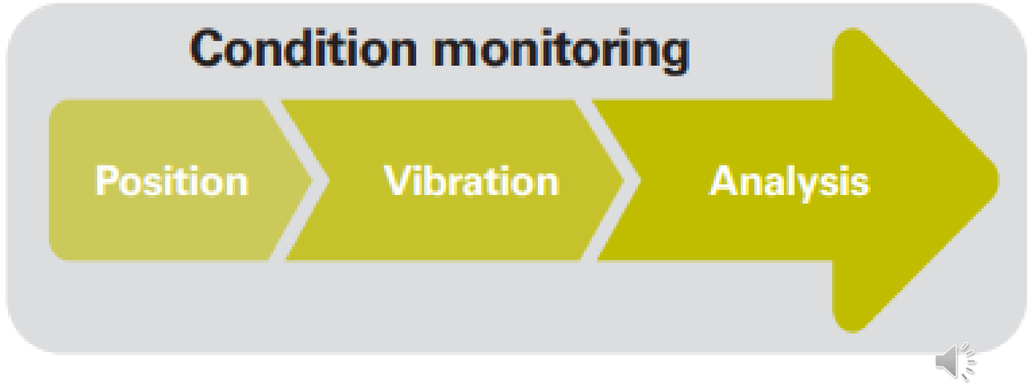
Organizzato da messe frankfurt

Motivation: Condition monitoring of rotating axes



The online condition monitoring of rotating machine elements enables:

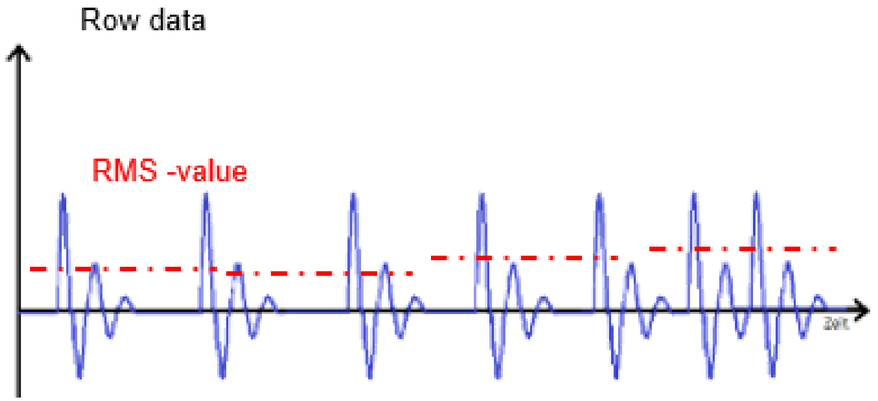
- Minimal downtime
- Higher productivity
- Early detection of damage
- Exact failure analysis
- Reduction of servicing intervals
- Maintenance planning
- Remaining service life estimation



Evaluating acceleration signals

Vibration characteristic value RMS

- An increase in the vibration characteristic value RMS indicates the wear of a component in the machine
- Benefits:
  - Simple statement about actual status
  - Easy to calculate
- Disadvantages:
  - Which component shows the wear/damage?
  - Susceptible to sturgeon
  - Limited informative value

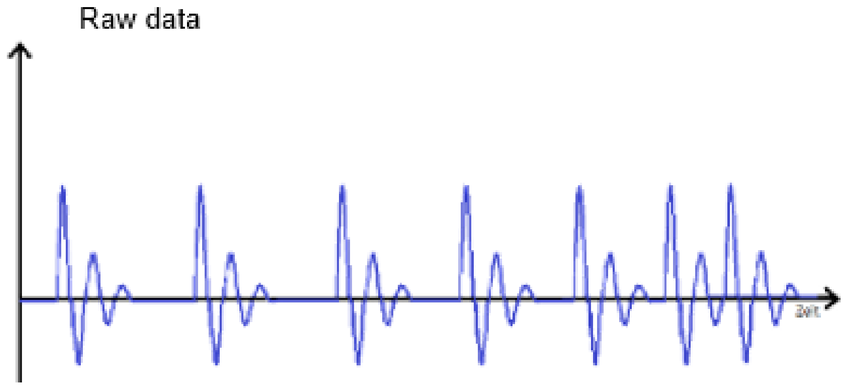


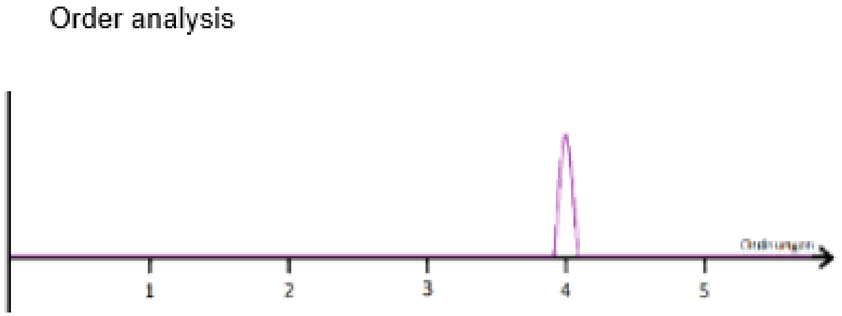
$$RMS = \sqrt{\frac{1}{n}\sum_{i} x_i^2}$$

Evaluating acceleration signals

Order analysis

- The order of each individual component (e.g. each individual part of a ball bearing) is known (manufacturer information)
- Benefits:
  - Identification of the defective component (e.g. outer ring of a ball bearing)
  - Analysis method with maximum sensitivity
  - Early detection of faults
  - Immune to external interference
  - Continuous monitoring in normal operation (varying speed)
- Disadvantages:
  - Vibration signals synchronised with the angle of rotation required





periodisches, stoßförmiges Ereignis

⇩

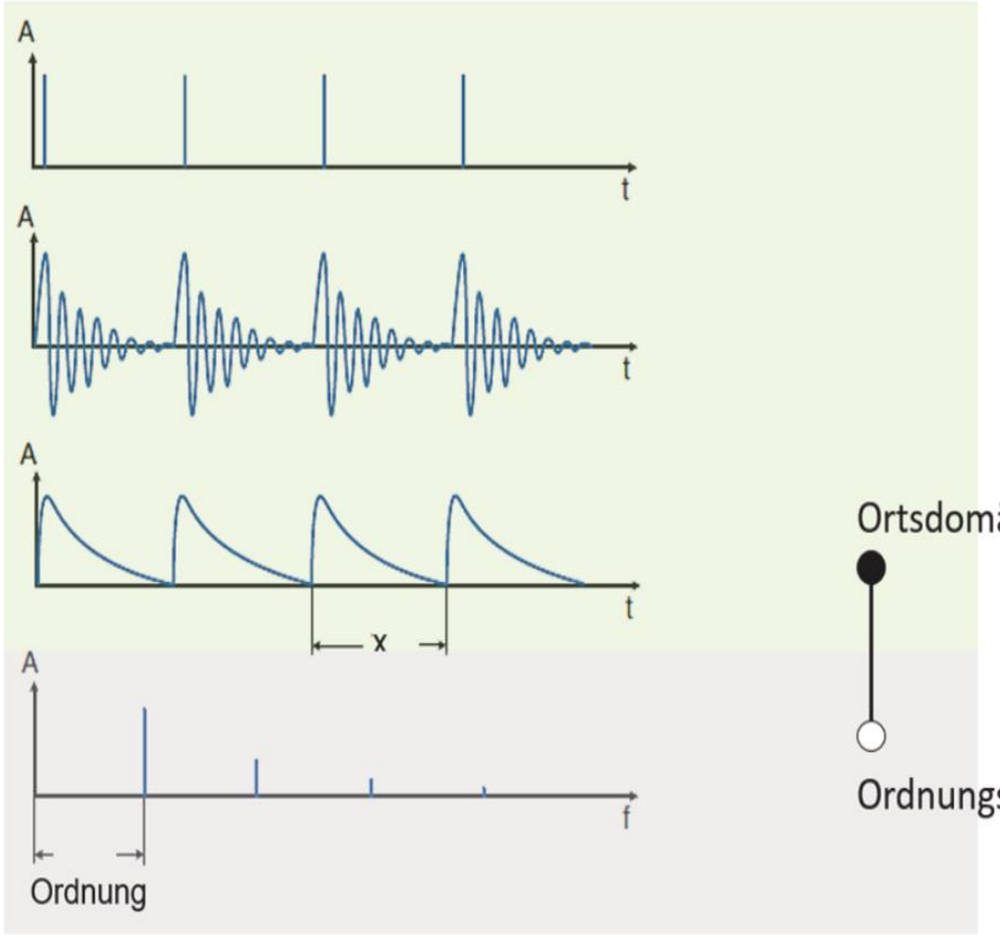
Reaktion der Struktur (Körperschall)

⇩

Bildung der Hüllkurve

⇩

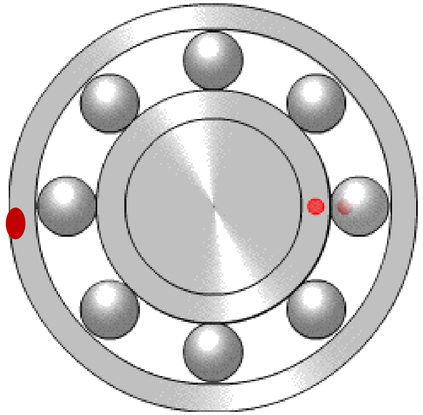
Hüllkurvenspektrum



Quelle: Maschinenelemente 2, Berthold Schlecht

Ortsdomäne

Ordnungsdomäne

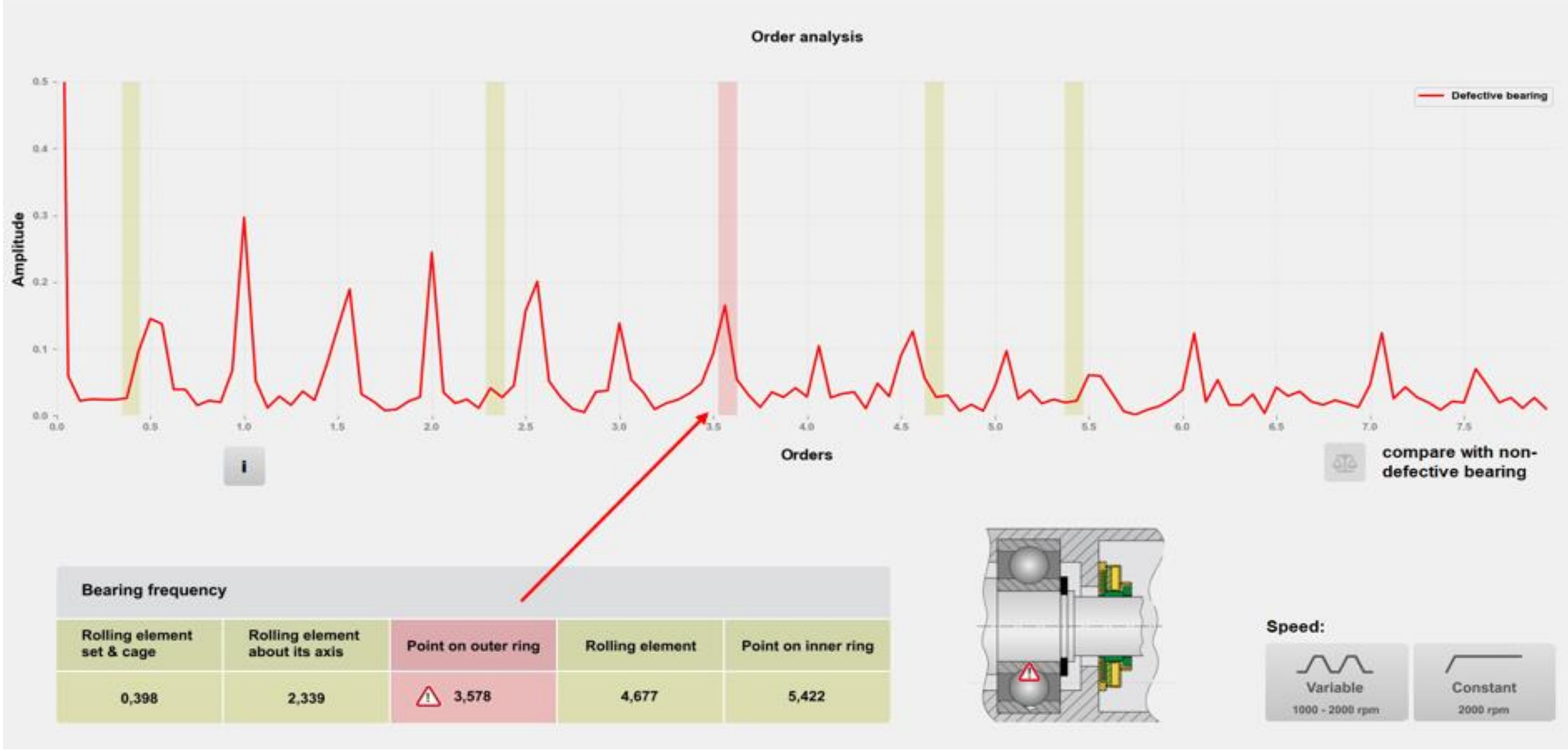


Damage

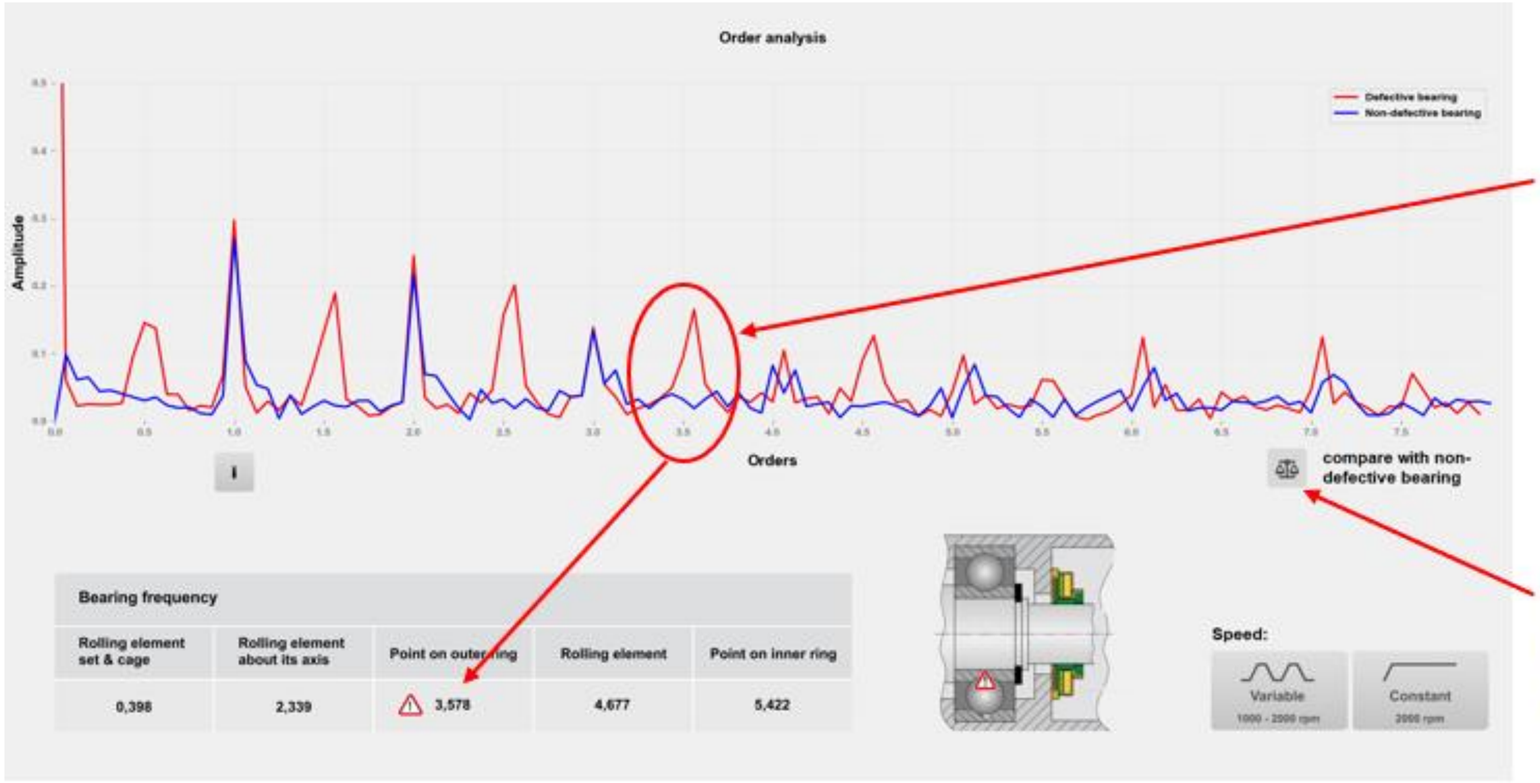
earing frequency				
lling element t & cage	Rolling element about its axis	Point on outer ring	Rolling element	Point on inner ring
0,398	2,339	3,578	4,677	5,422

Measurement - Display

Measurement - Display

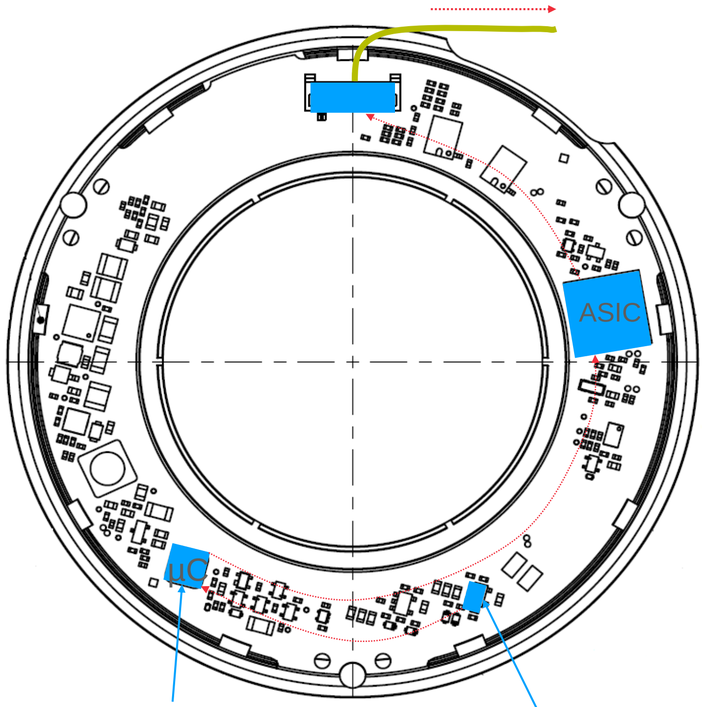


Measurement - Display



Significant amplitude change can be seen in the order of the outer ring!

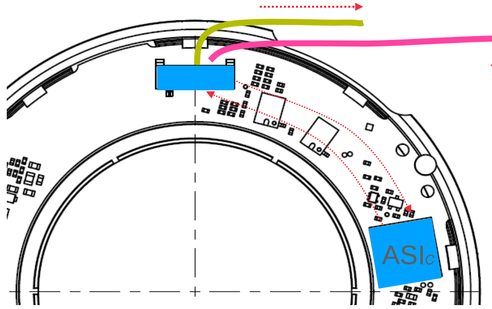
Showing the measured values of an undamaged ball bearing as a reference (see blue curve)



Data processing e.g. order analysis

Acceleration sensor

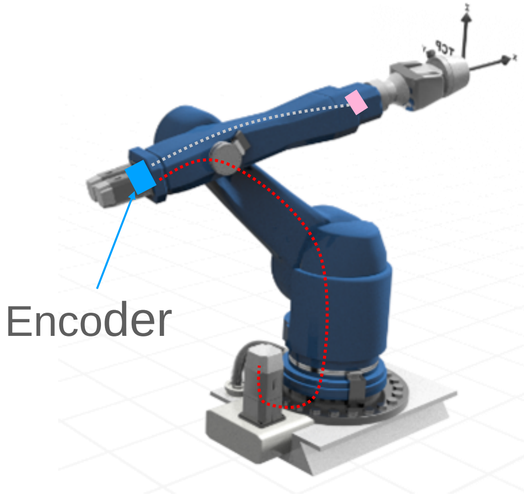
- Integrate external sensor into interface data stream



Raw data

µC or FPGA

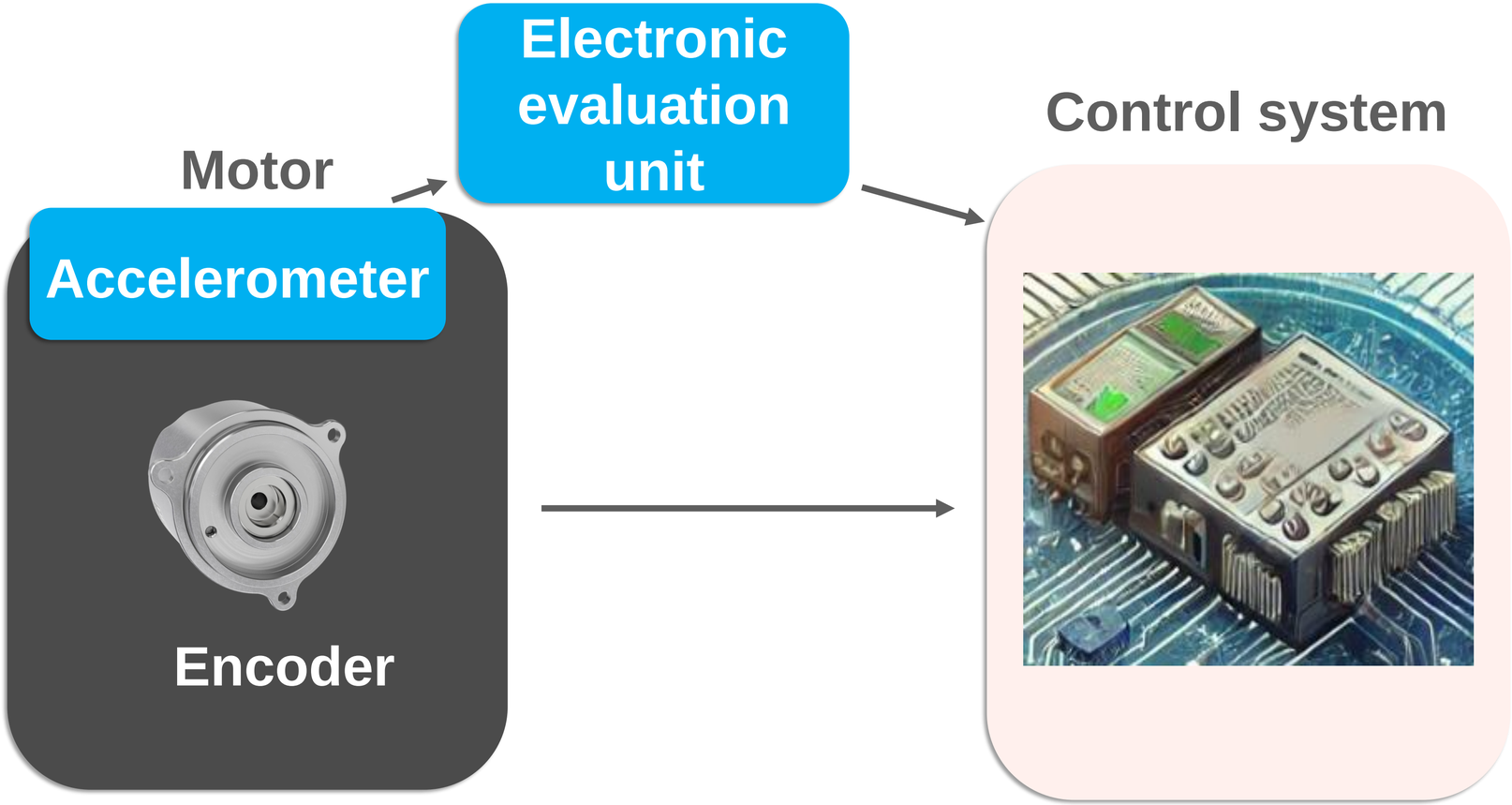
Acceleration sensor



Encoder

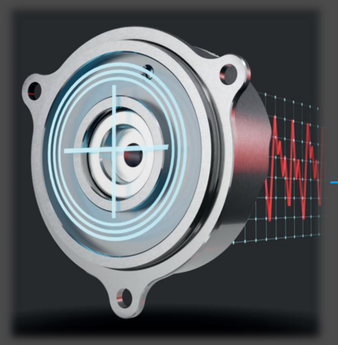
robot axis dampening

Previously: Separate accelerometer



Integrated accelerometer

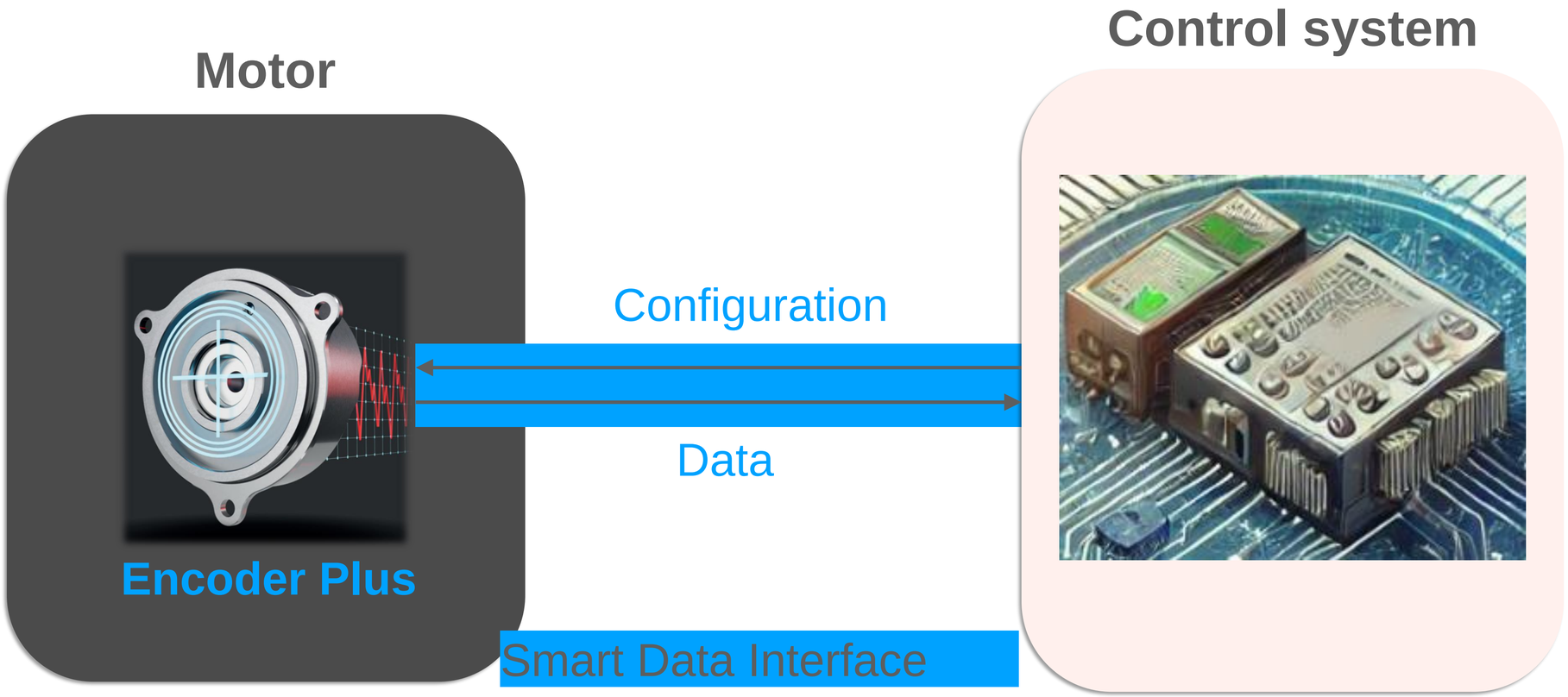
Motor



Encoder Plus

Control system

Integrated accelerometer



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GRAZIE PER L'ATTENZIONE

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Motor feedback encoder for servomotors

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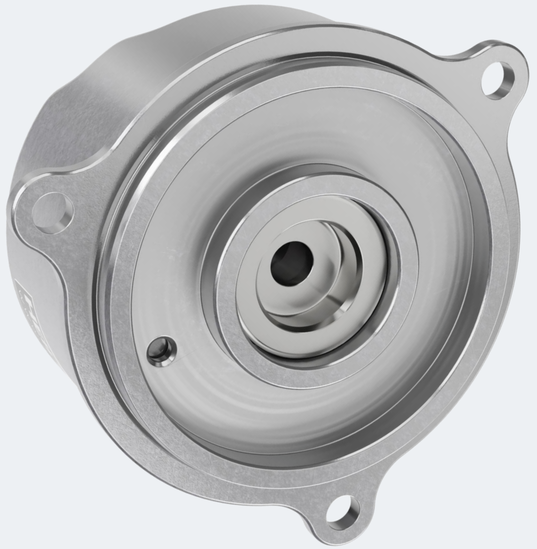

ExI 13xx *Splus*

- Inductive scanning
- Resolution 23 bit
- Multiturn option 12 bit
- Interface EnDat 3

+

- Integrated 3D MEMS accelerometer
- Vibration analysis

Prototypes available

Technical data

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Accelerometer	
Measuring range	±15 g, ±30 g, ±60 g
Measuring step	16 bit
Bandwidth	bis 8000 Hz
Number of axes	3
Evaluation (configurable)	
Characteristic value	**RMS**
Vibration analysis	**Order and frequency analysis** - Envelope analysis and bandpass filter - Fast Fourier transformation - Monitoring function: 256 values - Speed trigger